Safety Pressure Switch Test

28. Disconnect the tubing to the pressure switch at the manifold and install a syringe and tee into the line to the pressure switch (Figure 3-6).

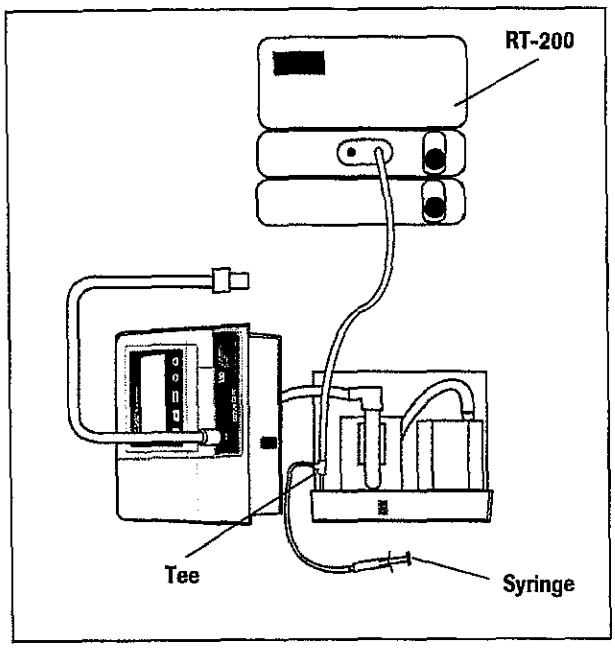

Figure 3-6: Safety Pressure Switch Test

29. Install a small-bore tube from the tee to the RT-200. Set the RT-200 to (#12) 250 cmH_2O.
30. Turn the unit on and use the syringe toapply to the switch. Verify that the blower stops running when the applied pressure is between 44 and 56 cmH_2O.
31. Turn the unit off and reconnect the tubing to the pressure switch.

Pressure Regulation and Set Point Accuracy

32. Install the test setup shown in Figure 3-2. Set the RT-200 to (#36) 180 lpm of air.
33 Turn the *KnightStar 335* on and verify that it is in the CPAP mode and set to an IPAP of 20 cmH_2O (remove the filter from the outlet for one second). Adjust the gate valve to produce a reading of 90 ± 3.2 lpm. Set the RT-200 to mode (#12) 250 cmH_2O). Record the pressure reading obtained in this step.
34. Set the RT-200 to (#36) 180 lpm of air. Adjust the gate valve until there is a flow of 30 ± 4.4 lpm. Set the RT-200 to (#12) 250 cmH_2O. Record the pressure obtained in this step.
35. Verify that the reading taken in step 35 is 20.0 ± 1 cmH_2O.
36. Compare the pressure readings between step 34 and 35. Verify that there is no more than 1 cmH_2O difference between the two readings.

Sensitivity Test

37. With the gate valve set per step 35, use the control module to set the following parameters:

Mode: I/E PAP	Default: E
IPAP: 20 cmH_2O	IPAP SENS: 1
EPAP: 3 cmH_2O	EPAP SENS: 5

38. Set the RT-200 (#12).
39. After 2 minutes verify that the unit is auto cycling at a slow rate, with IPAP time > 3 seconds.
40. Set the EPAP sensitivity to 1 and verify that the unit auto-cycles rapidly with IPAP time < 5.0 seconds.
41. Set IPAP sensitivity to 3 and verify that the unit stops auto-cycling. Verify no spontaneous switches to IPAP for a period of one minute.

Delay Test

42. Set the RT-200 (#12) 250 cmH_2O and set delay time for 5 minutes. Mode AC, IPAP 20 cmH_2O, EPAP 5 cmH_2O, RR to 10 bpm.
43. Activate the delay function and the stopwatch.
44. Verify pressure of 3.5 ± 0.4 cmH_2O.
45. Verify pressure begins to increase after 5 minutes.

Power Failure Indicator Verification

46. While the *KnightStar 335* is turned on and running, disconnect the AC power. Verify an audible alarm for at least 60 seconds.

Memory Verification

47. Plug the unit in and turn it on.
48. Record the unit's mode and setting.
49. Turn the unit off and unplug it.
50. Leave the unit unplugged for 30 minutes.
51. Plug the unit in and turn it on. Verify the mode and settings are as recorded in step 48.

Assembled Tests

52. Disconnect unit from AC source. Remove all test equipment and the bacteria filter. Assemble the base unit per section 4, procedure 1, steps **o** through **ae.**
53. Connect the control module to the *KnightStar 335* using the 6-foot cable.
54. Connect the unit to an AC source and verify the MAINS ON light is illuminated.
55. Turn the unit on. Verify that when the unit is first powered up, and the control panel DELAY LED and the three indicator LEDs momentarily light.
56. Verify the green POWER ON LED on the front panel is illuminated.
57. Toggle through all selectors and fields on the control module to verify that they are operational.
58. Enable the calibration outputs by simultaneously pushing the DOWN ARROW key and the DISPLAY key until a "C" is displayed.
59. Install the analog output cable into the EST NASAL PRESSURE analog output on the back of the control module. Verify the following outputs with the fluke 87 in the min/max mode: Output of + 0.5 to 0.0 ± 0.1 VDC.
60. Repeat step 60 for EST PATIENT FLOW and EST TIDAL VOLUME analog outputs. Verify the following outputs with the fluke 87 in the min/max mode: Output of 0.5 to -0.5 ±0.1 VDC.
61. Simultaneously press the DISPLAY and DOWN ARROW key until a "0" is displayed. Verify all analog outputs at 0.0 ± 0.1 volts.
62. Simultaneously press the DISPLAY and UP ARROW key to return the analog outputs to normal operation.
63. Connect a bacteria filter, the 6-foot smooth bore tube, pressure tee gate valve, and RT-200 to the outlet of the *KnightStar 335* as shown in figure 3-2.
64. Turn the unit on and use the control module to set the mode to CPAP with a pressure of 20 cmH_2O and remove filter from outlet for one second.
65. Set the RT-200 to the 180 lpm air range (#36). Adjust the gate valve to produce a reading of 30 ± 4.4 lpm.
66. Set the RT to (#12) 250 cmH_2O. Verify that the pressure indicated on RT-200 is 20 ±0.1 cmH_2O.
67. Remove the circuit assembly from the outlet of the unit.
68. Verify that the LEAK indication LED is illuminated within 60 to 80 seconds.
69. Set the delay interval to 5 minutes. Press the DELAY button and verify DELAY LED is illuminated. Turn the *KnightStar 335* off and disconnect control module from the base unit.

Current Leakage/Ground Line Resistance Test

70. Connect the AC power cord to the *KnightStar 335* rear panel receptacle and to an AC source. Verify that the rear panel AC indicator is illuminated. Disconnect the *KnightStar 335* from the AC source.
71. Connect the AC power cord to the electrical safety tester. Verify that ground line resistance is less than 0.1ohms between the power cord grounding pin and the *KnightStar 335*'s metal chassis.
72. Turn on the *KnightStar 335* and verify that the current leakage is less than 100 micro amperes for both normal and reverse polarity.

Remote Control Test (If Remote is Used)

73. Set the data rate switches in the remote control and the IR module in opposite positions.
74. Connect the IR module to the base unit. Place the power switch of the base unit in the ON position.
75. From approximately 15 feet away, verify that the *KnightStar 335* can not be activated or deactivated using the remote control.
76. Remove the IR module from the base unit and set the data rate switches on both the IR module and the remote control to the same data rate position.
77. From approximately 15 feet away, point the remote control toward the IR Module on the *KnightStar 335*. Verify that the *KnightStar 335* can be activated by pressing the appropriate remote control buttons.
78. Move the data rate switches, on both the IR module and the remote control, to the opposite position. Repeat step 75.
79. Return the switches to their original settings.
80. Disconnect unit from AC source.

Table 3-3 Troubleshooting Guide

Troubleshooting procedures for the *KnightStar 335* system are presented in Table 3-3. The information presented is not all-inclusive but is intended to serve as a general outline for solving problems found during the performance verification procedure. This table describes symptoms, identifies possible causes and suggests corrective actions. For operational troubleshooting, refer to the Patient Guide located in Section 1 of this manual.

WARNING:

If any operational problem cannot be solved, do not use the *KnightStar 335* on a patient. Contact Nellcor Puritan Bennnett.

NOTE:

When more than one possible cause is identified, the possible causes are listed in order of most likely to the least likely reasons for failure.

Symptom	Possible Cause	Corrective Action
Maximum Flow Test		
1. (Test step 10) Flow from the *KnightStar 335* is not greater than 102 lpm	a. Flow tester is out of calibration	a. Calibrate flow tester and retest.
	b. Tubing kinked	b. Verify no kinks in tubing from outlet of rotary actuator to flow tester.
	c. Leaks in tubing	c. Verify no leaks from outlet of rotary actuator to the flow tester.
	d. Faulty motor/blower assembly item 15, Figure 4-2	d. Replace motor/blower assembly per instructions in Table 4-1.
	e. Faulty rotary actuator valve item 25, Figure 4-2	e. Replace rotary actuator valve per instructions in Table 4-1.
	f. Faulty power controller PCB, item 7, Figure 4-3	f. Replace power controller PCB per instructions in Table 4-1.
2. (Test step 13) Current draw is greater than 2.475 amps	a. Test equipment out of calibration	a. Calibrate test equipment and retest.
	b. Inlet filters occluded	b. Clean inlet filter and retest.
	c. Faulty motor/blower assembly item 15, Figure 4-2	c. Replace motor/blower assembly per procedure outlined in Table 4-1.
	d. Faulty power controller PCB item 7, Figure 4-3	d. Replace power controller PCB per procedure outlined in Table 4-1.
	e. Faulty power supply item 26, Figure 4-3	e. Replace power supply per procedure outlined in Table 4-1.
	f. Faulty CPU PCB item 11, Figure 4-3	f. Replace CPU PCB per procedures outlined in Table 4-1.

Symptom	Possible Cause	Corrective Action
Flow Transducer Check		
3. (Test step 17) Voltage is greater than 0.00 ± 0.049 VDC	a. DVM connected incorrectly	a. Verify proper connection of DVM and retest.
	b. Ports on flow transducer not capped	b. Cap ports of transducer and retest.
	c. Faulty CPU PCB, item 11, Figure 4-3	c. Replace CPU PCB per instructions in Table 4-1.
	d. Faulty power controller PCB item 7, Figure 4-3	d. Replace power controller PCB per instructions in Table 4-1.
4. (Test step 20) Voltage on DVM is not 5.00 ± 0.2 VDC	a. Polarity is reversed on tubing connected to flow transducer	a. Verify proper tubing connection to flow transducer.
	b. RT-200 is out of calibration flow range is not within test limits	b. Zero the RT-200 and retest.
	c. Faulty CPU PCB item 11, Figure 4-3	c. Replace CPU PCB per instructions in Table 4-1.
	d. Faulty power controller PCB item 7, Figure 4-3	d. Replace power controller PCB per procedure in Table 4-1.
Front Panel Indicator		
5. (Test step 25) LEAK indication LED does not illuminate within 60 to 80 seconds	a. Flow rate is not greater than 130 lpm	a. Check calibration of RT-200 and retest flow rate.
	b. Faulty keypad item 2, Figure 4-1	b. Replace top housing per instructions in Table 4-1.
	c. Faulty CPU PCB item 11, Figure 4-3	c. Replace CPU PCB per instructions in Table 4-1.
	d. Faulty ribbon cable item 19, Figure 4-1	d. Replace ribbon cable per instructions in Table 4-1.
6. (Test step 26) INOPERATIVE LED did not illuminate in 15 seconds	a. Faulty CPU PCB item 11, Figure 4-3	a. Replace CPU PCB per instructions in Table 4-1.
	b. Faulty display board item 8, Figure 4-5	b. Replace display board per instructions in Table 4-1.
	c. Faulty connector PCB item 14, Figure 4-5	c. Replace connector PCB per instructions in Table 4-1.
Safety Pressure Switch Tests	a. RT-200 out of calibration	a. Check calibration and retest.
7. (Test step 30 and 31) Motor/ blower assembly not turning on and off at proper pressure	b. Faulty pressure switch item 2, Figure 4-3	b. Change pressure switch per instructions in Table 4-1.
	c. Faulty power controller PCB item 7, Figure 4-3	c. Replace power controller PCB per instructions in Table 4-1.

Symptom	Possible Cause	Corrective Action
Pressure Regulation		
8. (Test step 36) More than 1.0 cmH_2O variation in pressure between two tests	a. RT-200 out of calibration b. Filters dirty c. Faulty CPU PCB item 11, Figure 4-3 d. Faulty power controller PCB item 7, Figure 4-3 e. Faulty rotary actuator item 25, Figure 4-2	a. Calibrate RT-200 and retest. b. Clean filters and retest. c. Replace CPU PCB per instructions in Table 4-1. d. Replace power controller PCB per instructions in Table 4-1. e. Replace rotary actuator per instructions in Table 4-1.
Set Point Accuracy		
9. (Test step 40) Pressure is not 20.0 + 0.5 cmH_2O	a. RT-200 out of calibration b. Filters dirty c. Pressure transducer out of calibration d. Faulty CPU PCB item 11, Figure 4-3 e. Faulty power controller PCB item 7, Figure 4-3 f. Faulty rotary actuator item 25, Figure 4-2	a. Calibrate RT-200 and retest. b. Clean filters and retest. c. Perform calibration procedure 4.2 on page 4-22. d. Replace CPU PCB per instructions in Table 4-1 steps. e. Replace power controller PCB per instructions in Table 4-1. f. Replace rotary actuator per instructions in Table 4-1.
Sensitivity Tests		
10. (Test steps 43 through 45) Spontaneous cycling does not react as described in tests	a. Improper test set-up b. Faulty CPU PCB item 11, Figure 4-3 c. Faulty power controller PCB item 7, Figure 4-3	a. Verify test settings and retest. b. Replace CPU PCB per instructions in Table 4-1. c. Replace power controller PCB per instructions in Table 4-1.
Delay Test		
11. (Test step 48) Pressure not 3.5 cmH_2O + 0.4	a. Flow rate is not greater than 130 lpm b. Faulty keypad item 2, Figure 4-1 c. Faulty CPU PCB item 11, Figure 4-3 d. Faulty ribbon cable item 19, Figure 4-1	a. Check calibration of RT-200 and retest flow rate. b. Replace top housing per instructions in Table 4-1. c. Replace CPU PCB per instructions in Table 4-1. d. Replace ribbon cable per instructions in Table 4-1.
Power Failure Indicator Test		
12. (Test step 50) No audible alarm or alarm does not sound for at least 60 seconds	a. Faulty capacitor item 6, Figure 4-3 b. Faulty power controller PCB item 7, Figure 4-3 c. Faulty CPU PCB item 11, Figure 4-3	a. Change capacitor per instructions in Table 4-1. b. Replace CPU PCB per instructions in Table 4-1. c. Replace CPU PCB per instructions in Table 4-1.

Symptom	Possible Cause	Corrective Action
Assembled Tests		
13. (Test step 56) DELAY indicator LED and three indicator LEDs did not light during power up	a. Unit not assembled properly	a. Carefully open the unit per instructions in Table 4-1 and verify that all cables are connected properly.
	b. Faulty front panel item 2, Figure 4-1	b. Replace front panel per instructions in Table 4-1.
	c. Faulty CPU PCB item 11, Figure 4-3	c. Replace CPU PCB per instructions in Table 4-1.
	d. Faulty power controller PCB item 7, Figure 4-3	d. Replace CPU PCB per instructions in Table 4-1.
14. (Test step 57) Green POWER ON LED is not illuminated	a. Unit not assembled properly	a. Carefully open the unit per instructions in Table 4-1 and verify that all cables are connected properly.
	b. Faulty front panel item 2, Figure 4-1	b. Replace front panel per instructions in Table 4-1.
	c. Faulty CPU PCB in item 11, Figure 4-3	c. Replace CPU PCB per instructions in Table 4-1.
	d. Faulty power controller PCB item 7, Figure 4-3	d. Replace power controller PCB per instructions in Table 4-1.
15. (Test step 58) All fields on the control module are not operational	a. Unit not assembled properly	a. Carefully open the unit per instructions in Table 4-1 and verify that all cables are connected properly.
	b. Faulty connector PCB item 14, Figure 4-5	b. Replace connector PCB per instructions in Table 4-1.
	c. Faulty keypad in control module item 10, Figure 4-5	c. Replace keypad per instructions in Table 4-1.
	d. Faulty CPU PCB in item 11, Figure 4-3	d. Replace CPU PCB per instructions in Table 4-1.
16. (Test steps 60 and 61) Improper voltage readings at analog outputs	a. Faulty CPU PCB in item 11, Figure 4-3	a. Replace CPU PCB per instructions in Table 4-1.
	b. Faulty power controller PCB item 7, Figure 4-3	b. Replace power controller PCB per instructions in Table 4-1.
	c. Faulty connector PCB item 14, Figure 4-5	c. Replace connector PCB per instructions in Table 4-1.

Symptom	Possible Cause	Corrective Action
17 (Test step 64) Set pressure is not 20 ± 0.5 cmH_2O	a. RT-200 out of calibration	a. Calibrate RT-200 and retest.
	b. Unit not properly assembled	b. Carefully open the unit per instructions in Table 4-1 and verify that all cables are connected properly.
	c. Faulty CPU PCB in item 11, Figure 4-3	c. Replace CPU PCB per instructions in Table 4-1.
Electrical Safety/Load Current Test		
18. (Test step 70) Rear panel AC indicator not illuminated	a. *KnightStar 335* fuse(s) blown	a. Replace blown fuse(s).
	b. Faulty AC power cord	b. Replace AC power cord.
	c. Faulty AC power module item 22, Figure 4-3	c. Replace AC power module per Table 4-1 service procedures.
	d. Faulty power controller PCB item 7, Figure 4-3	d. Replace power controller PCB per instructions in Table 4-1.
19. (Test step 71) Ground line resistance greater than .075 ohm	a. Electrical safety tester not calibrated properly	a. Recalibrate electrical safety tester and retest.
	b. Faulty AC power cord	b. Replace AC power cord.
	c. Disconnected or faulty ground wire harness item	c. Check integrity of ground wire, tighten or replace as necessary.
	d. Faulty AC power module item 22, Figure 4-3	d. Replace AC power module per Table 4-1 service procedures.
20. (Test step 72) Current leakage is greater than 90 micro amperes	a. Test meter out of calibration	a. Calibrate test meter and retest.
	b. Faulty power cord	b. Replace power cord and retest.
	c. Faulty AC power module	c. Replace AC power module per Table 4-1 service procedures and retest.
	d. Faulty ground connection	d. Check the integrity of the internal ground and retest.
	e. Faulty RFI filter, item 3, Figure 4-2	e. Replace filter per procedure outlined Figure 4-2 in Table 4-1 and retest.
	f. Faulty power cables, items 2 and 31, Figure 4-2	f. Replace power cables per procedure outlined in Table 4-1 and retest.

Section 4. Service and Repair

This section describes how to service the individual components of the *KnightStar 335*. Included are instructions where applicable, for removal, disassembly, calibration, reassembly and installation.

4.1 *KnightStar 335* Service Procedures

Service and replacement procedures for the *KnightStar 335* are provided in Table 4-1 as follows:

Component	Procedure number
Top housing assembly	1
Cooling fan	2
Audible alarm	3
Rotary actuator assembly	4
Motor/blower assembly	5
Power supply	6
CPU PCB	7
Power controller PCB	8

WARNING:
The *KnightStar 335* is electrically powered. To prevent serious injury or death, observe standard safety procedures. Ensure that power has been disconnected from the unit before servicing any component.

WARNING:
After a component has been serviced, the unit's overall system operation must be verified per Section 3.3 Performance Verification, before the unit is returned to patient service.

CAUTION:
Circuit boards contain complementary metal-oxide semiconductor (CMOS) integrated circuits (IC's) which are static sensitive devices. To prevent IC damage, observe standard safety procedures as follows:
- Handle circuit boards by edges only
- Work on grounded conductive mat
- Wear grounded wrist strap
- Store circuit boards in conductive plastic bags

Table 4-1 Service Procedures

(Refer to appropriate figure[s] for numbers shown in **bold** print)

Component	Step/Item	Action
4.1.1 Top housing assembly 4 (Figure 4-1)		**WARNING:** The *KnightStar 335* is electrically powered. To prevent serious injury or death, observe standard safety procedures. Ensure that power has been disconnected from the unit before servicing any component.
Removal	a. *KnightStar 335* unit	a. Turn off and disconnect from AC. Remove all cables and tubes. Remove inlet baffle **8** and filter **7**. Turn the unit so that the back is facing towards you.
	b. Acorn nuts **6** and lock washers **5**	b. Remove from back of KnightStar 335.
	c. *KnightStar 335* unit	c. Place the KnightStar 335 unit on its back with the bottom facing towards you.
	d. Two screws **17**	d. Remove two screws from bottom of KnightStar 335.
	e. Two brackets **16**	e. Pull the two brackets out of the bottom of the KnightStar 335.
	f. Handle **18**	f. Pull handle out of the front of the KnightStar 335. Remove from KnightStar 335 unit.
	g. Six screws **15**	g. Remove from KnightStar 335 unit.

Component	Step/Item	Action
	h. *KnightStar 335* unit	h. Place unit back on its bottom feet with one of the sides facing towards you. Slide the top housing assembly about two inches towards the front of the machine.
		CAUTION: Forcing the top housing assembly too far forward at this time could cause damage to internal cables or tubing.
	i. *KnightStar 335* unit	i. Carefully turn the *KnightStar 335* unit onto its side with the bottom facing towards you.
	j. Wire harness **19**	j. Reach up into the top housing assembly and disconnect wire harness **19** from the front keypad **2**.
	k. Flex tubing **6** (Figure 4-2)	k. Reach up into the top housing assembly and disconnect the flex tube from the machine outlet **3**.
	l. *KnightStar 335* unit	l. Place the unit in an upright position with one of the sides facing towards you. Slide the top housing assembly another two to three inches forward.
	m. Wire harness **22**	m. Disconnect wire harness **22** from PCB **11** on Figure 4-3.
Installation	n. Top housing assembly	n. Slide top housing assembly forward away from the back of the *KnightStar 335* unit until it is completely separated from the *KnightStar 335* unit.
	o. Top housing assembly	o. Slide top housing assembly partially onto *KnightStar 335* unit.
	p. Wire harness **22**	p. Connect wire harness **22** to connector J2 on CPU PCB (refer to Figure 4-4).
	q. Top housing assembly	q. Slide the top housing assembly onto the *KnightStar 335* unit leaving enough room for access to connections inside of the unit.
	r. *KnightStar 335* unit	r. Carefully turn the *KnightStar 335* unit on its side with the bottom facing towards you.
	s. Flex tube **6** (Figure 4-2)	s. Reach up inside of the *KnightStar 335* unit and connect flex tube **6** to machine outlet **3**.
	t. Wire harness **19**	t. Reach up inside of the unit and connect wire harness to keypad **2**.
	u. *KnightStar 335* unit	u. Place the *KnightStar 335* unit in the upright position.

Component	Step/Item	Action
	v. Top assembly **4**	v. Slide top assembly onto the *KnightStar 335* unit.
		NOTE: It may be necessary to leave a small gap between the top housing and the back of the *KnightStar 335* to aid in alignment of posts 1 with the back of the *KnightStar 335.*
	w. Lock washers **5**	w. Place the lock washers and acorn and acorn nuts **6** nuts on the studs protruding through the back plate. Do not tighten the acorn nut at this time.
	x. *KnightStar 335* unit	x. Place the *KnightStar 335* unit on its back side with the bottom facing towards you.
	y. Six screws **15**	y. Insert the six screws through the top housing and tighten.
	z. Handle **18**	z. Install the handle through the two holes in the front of the top housing assembly.
	aa. Two brackets **16**	aa. Orient the brackets as illustrated and insert through the slots in the bottom of the *KnightStar 335* unit.
	ab. Two screws **17**	ab. Insert two screws through the brackets and tighten.
4.1.2. Cooling fan **16** (Figure 4-3)	ac. *KnightStar 335* unit	ac. Place the *KnightStar 335* unit in the upright position.
	ad. Acorn nuts **6**	ad. Tighten the acorn nuts.
Removal	ae. Filter **7** and inlet baffle **8**	ae. Reinstall the filter and inlet baffle on the back of the *KnightStar 335* unit.
	a. Top housing assembly **4**	a. Perform removal procedure 1 (Figure 4-1) (steps a through n) Table 4-1.
	b. Flex tube **10**	b. Disconnect flex tube from motor/blower assembly **15** (Figure 4-2).
IInstallation	c. Cooling fan **16**	c. Disconnect fan harness from PCB 7. Remove four screws **14b** and nuts **17a** and fan guard **15b**.
	d. Fan guard **15a**	d. Remove two screws **14a** and nuts **17b**.
	e. Fan guard **15a**	e. Install two screws **14a** through guard and tighten to fan with two nuts **17b**.
	f. Fan guard **15b**	f. Orient fan guard as shown and pass four screws **14b** through corners of fan guard and back plate of *KnightStar 335*.

Component	Step/Item	Action
	g. Cooling fan **16**	g. Pass cooling fan over four screws **14b**. Secure fan to back plate with four nuts **17a** and connect to PCB 7.
4.1.3. Audible alarm 24 (Figure 4-3)		
Removal	h. Flex tube **10**	h. Connect to motor/blower assembly **15** (Figure 4-2).
	i. Top housing assembly **4**	i. Follow installation procedure 1 (Figure 4-1) (steps o through ae).
Installation	a. Top housing assembly **4**	a. Perform removal procedure 1 removal (Figure 4-1) (steps a through n) Table 4-1.
	b. Audible alarm **24** harness	b. Disconnect from J8 on power controller PCB (Figure 4-4).
	c. Audible alarm **24**	c. Remove two screws **25**.
	d. Audible alarm **24**	d. Mount audible alarm to back plate of *KnightStar 335* with two screws **25**.
4.1.4. Rotary actuator assembly 25 (Figure 4-2)	e. Audible alarm harness	e. Connect to J8 of power controller PCB (Figure 4-4).
Removal	f. Top housing assembly **4**	f. Follow installation procedure 1 (Figure 4-1) (steps o through ae) Table 4-1.
	a. Top housing assembly **4**	a. Perform removal procedure 1 (Figure 4-1) (steps a through n) Table 4-1.
	b. Tubing **29** and **30**	b. Remove tubes from valve manifold **27** making sure to mark the original location.
		NOTE: Before disconnecting tubing mark its location.
	c. RFI filter **3**	c. Disconnect wire harness **2** and **31** being sure to mark the original location of the connections.
		NOTE: Before disconnecting wiring mark its location.
	d. Tie wrap **32**	d. Cut tie wrap and discard.
	e. Two screws **1**	e. Remove the two screws and the RFI filter.
	f. Pitot tube **5**	f. Disconnect pitot tube from valve manifold.
	g. *KnightStar 335* unit	g. Place the *KnightStar 335* unit on its back with the internal components facing towards you.

Component	Step/Item	Action
	h. Upper and lower manifold	h. Remove four screws **28** from each brackets **26** bracket. Carefully remove each bracket.
	i. Valve manifold **27**	i. Separate valve manifold from rotary actuator assembly **25**.
	j. *KnightStar 335* unit	j. Place the *KnightStar 335* unit in an upright position with the front facing towards you.
	k. Rotary actuator assembly **25**	k. Disconnect the rotary actuator assembly wire harness from J11 on power controller PCB (Figure 4-4).
	l. *KnightStar 335* unit	l. Turn the *KnightStar 335* unit so that the back is facing towards you.
	m. Sound bracket **8**	m. Remove six screws **7** from sound bracket. Remove sound bracket from housing **11**.
	n. Flex tube **10**	n. Disconnect flex tube from motor/blower assembly **15**. Disconnect flex tube from rotary actuator assembly. Remove flex tube from housing **11**. Remove four screws **9**.
	o. Rotary actuator assembly **25**	o. Remove the rotary actuator assembly.
		NOTE: As screws **9** are being loosened hold the rotary actuator assembly to prevent it from falling onto the PCBs.
Installation	p. *KnightStar 335* unit	p. Place the unit in an upright position with one of the sides facing towards you.
	q. Rotary actuator assembly **25**	q. Place one screw **9** in position and align rotary actuator assembly with screw. Partially tighten the screw. Install remaining screws **9** and tighten all four.
	r. Rotary actuator assembly	r. Connect to J11 on power controller wire harness PCB (Figure 4-4).
	s. Flex tube **10**	s. Pass flex tube through hole in side of housing **11**. Connect flex tube to rotary actuator assembly **25**. Connect flex tube to motor/blower assembly **15**.
	t. Sound bracket **8**	t. Place sound bracket in housing **11**. Tighten six screws 7 in sound bracket.
	u. *KnightStar 335* unit	u. Place the unit on its back with the internal components facing you.
	v. Valve manifold **27**	v. Place upper manifold bracket **26** on valve manifold. Place valve manifold on rotary actuator assembly.

Component	Step/Item	Action
	w. Manifold bracket **26**	w. Place bottom manifold bracket on valve manifold **27**. Place four screws **28** in each of the manifold brackets. Tighten all eight screws **28**.
		NOTE: Alternately tighten each of the screws until all eight are completely tight.
	x. *KnightStar 335* unit	x. Place *KnightStar 335* unit in upright position with the left side facing towards you.
	y. RFI Filter **3**	y. Place one screw **1** in screw hole in RFI filter and align it with the hole in the rotary actuator assembly. Partially tighten the screw. Place second screw **1** in RFI filter and tighten both of them.
	z. Wire harness **2** and **31**	z. Reconnect to RFI filter.
4.1.5. Motor/blower assembly 15 (Figure 4-2)	aa. Tubing **29** and **30**	aa. Reconnect tubing to valve manifold **27**.
	ab. Pitot tube **5**	ab. Reconnect pitot tube to valve manifold **27**.
	ac. Tie wrap **32**	ac. Install new tie wrap.
Removal	ad. Top housing assembly **4**	ad. Follow installation procedure 1 (Figure 4-1) (steps o through ae) Table 1-1.
	a. Top housing assembly **4**	a. Follow removal procedure 1 (Figure 4-1) (steps a through n) Table 4-1.
	b. Flex tube **10**	b. Disconnect flex tube from motor/blower assembly outlet.
	c. Motor/blower assembly	c. Disconnect harness from J1 wire harness on power controller PCB (Figure 4-4).
	d. Connector tube **12**	d. Cut tie wraps **13** and discard. Disconnect tube **12** from motor/blower assembly.
	e. *KnightStar 335* unit	e. Place the *KnightStar 335* unit on its back with the bottom facing towards you.
		NOTE: Secure the motor/blower assembly before proceeding to prevent it from falling.
	f. Motor/blower assembly **15**	f. While holding the motor/blower assembly remove four acorn nuts **22** and lock washers **21**. Remove motor/blower assembly from the *KnightStar 335* unit.

Component	Step/Item	Action
Installation	g. Bracket **17**	g. Remove two bolts **19** and lock washers **18**. Separate bracket from motor/blower assembly. Remove nuts **14** and separate second bracket from motor/blower assembly.
	h. Vibration mounts **20**	h. Remove nut **16** and separate vibration mount from bracket.
	i. Vibration mounts **20**	i. Place vibration mount on bracket and secure in place with nut **16**.
	j. Brackets **17**	j. Pass bolts **19** and lock washer **18** through holes in bracket. Tighten bolts in motor/blower assembly **15**. Connect second bracket with nuts **14**.
		NOTE: The 90° angle on each bracket should point to the center of the motor/blower assembly.
	k. Motor/blower assembly **15**	k. Align vibration mount studs with holes in bottom plate of *KnightStar 335* unit. Place lock washers **21** and acorn nuts **22** on vibration mount studs and tighten.
	l. Motor/blower assembly	l. Connect wire harness to J1 on wire harness power controller PCB (Figure 4-4).
4.1.6. Power supply PCB 26 (Figure 4-3)	m. Connector tube **12**	m. Connect tube to outlet of motor/blower assembly **15**. Install new tie wraps **13**.
Removal	n. Flex tube **10**	n. Connect to outlet of motor/blower assembly **15**.
	o. Top housing assembly **4**	o. Follow installation procedure 1 (Figure 4-1) (steps o through ae) Table 4-1.
Installation	a. Top housing assembly **4**	a. Perform removal procedure 1 (Figure 4-1) (steps a through n) Table 4-1.
	b. Wire harness **2** and **23** (Figure 4-2)	b. Disconnect from power supply PCB.
	c. *KnightStar 335 unit*	c. Place the unit on its back with the bottom facing towards you.
	d. Power supply PCB **26**	d. Remove four screws **27**.
		CAUTION: Use anti-static procedures outlined at the beginning of Section 4.

Component	Step/Item	Action
	e. Power supply PCB 26	e. Place one screw **27** in bottom case and align with hole in power supply PCB. Partially tighten screw **27** to keep PCB in place. Install three screws **27** through the case and into PCB then four screws.
4.1.7. CPU PCB 11 (Figure 4-3)	f. Wire harness **2** and **23**	f. Connect to power supply PCB (Figure 4-2) (Figure 4-4).
	g. Top housing assembly **4**	g. Follow installation procedure 1 (Figure 4-1) (steps o through ae) Table 4-1.
		CAUTION: Circuit boards contain complementary metal-oxide semiconductor (CMOS) integrated circuits (IC's) which are static sensitive devices. To prevent IC damage, observe standard safety procedures as follows: • Handle circuit boards by edges only • Work on grounded conductive mat • Wear grounded wrist strap • Store circuit boards in conductive plastic bags
Removal		
	a. Top housing assembly **4**	a. Perform removal procedure 1 (Figure 4-1) (steps a through n) Table 4-1.
	b. Rotary actuator assembly **25**	b. Perform removal procedure 2 (Figure 4-2) (steps a through o) Table 4-1.
	c. Housing **11** (Figure 4-2)	c. Pull housing out of back of *KnightStar 335* unit.
	d. Capacitor **6**	d. Do not disconnect the capacitor, move it clear of your working area. Remove nut **5** and nylon clamp **4**.
	e. Pressure switch plate **1**	e. Disconnect pressure switch **2** from J10 on PCB 7. Remove nut **5** and take pressure switch plate out of *KnightStar 335* unit.
Installation		
	f. Wire harness **19** (Figure 4-1)	f. Disconnect wire harness from J1 on CPU PCB **11**. Remove five screws **10**.
	g. CPU PCB **11**	g. Remove CPU PCB and store in an anti-static bag.
	h. CPU PCB **11**	h. Remove CPU PCB from anti-static bag. Align CPU PCB with five standoffs **9** and install five screws **10**.
	i. Pressure switch plate **1**	i. Place switch plate over studs **29**. Install rear nut **5** only.

Component	Step/Item	Action
	j. Capacitor **6**	j. Place nylon clamp **4** on front stud **29**. Slide capacitor **6** through nylon clamp and install nut **5** on front stud.
4.1.8. Power controller PCB 7 (Figure 4-3)	k. Pressure switch **2**	k. Connect switch harness to J10 on PCB **7**.
	l. Housing **11**	l. Insert housing in back plate of *KnightStar 335*.
	m. Rotary actuator assembly **25**	m. Follow installation procedure 2 (Figure 4-2) (steps p through ab) Figure 4-2.
	n. Top housing assembly **4**	n. Follow installation procedure 1 (Figure 4-1) (steps o through ae) Figure 4-1.
Removal		**CAUTION:** *Circuit boards contain complementary metal-oxide* semiconductor (CMOS) integrated circuits (IC's) which are static sensitive devices. To prevent IC damage, observe standard safety procedures as *follows:* • Handle circuit boards by edges only • Work on grounded conductive mat • Wear grounded wrist strap • Store circuit boards in conductive plastic bags
	a. Top housing	a. Perform removal procedure 1 assembly **4** (Figure 4-1, steps a through n) Table 4-1.
	b. Rotary actuator assembly **25**	b. Perform removal procedure 2 (Figure 4-2) (steps a through o) Table 4-1.
	c. CPU PCB **11**	c. Perform removal procedure 6 (steps a through g).
	d. Motor/blower assembly **15**	d. Disconnect from J1 on power (Figure 4-2) wire harness controller PCB **7**.
	e. Cooling fan **16** wire harness	e. Disconnect from J9 on power controller PCB **7**.
	f. Audible alarm **24** wire harness	f. Disconnect from J8 on power controller PCB **7**.
	g. Power supply wire harness **23**	g. Disconnect from J3 on power (Figure 4-2) controller PCB **7**.
	h. Capacitor **6** harness	h. Disconnect from J5 on power controller PCB **7**.
	i. Wire harness **31** (Figure 4-2)	i. Disconnect from J4 on power controller PCB **7**.
Installation	j. Four screws **30** and nuts **20**	j. Remove four screws and nuts from chassis.
	k. Five standoffs **9**	k. Remove five standoffs from power controller PCB **7**.
	l. Power controller PCB **7**	l. Remove power controller PCB and store in an anti-static bag.

Component	Step/Item	Action
	m. Power controller PCB **7**	m. Remove power controller PCB from anti-static bag. Apply heat sink to the back of the transistors. Place power controller PCB inside of *KnightStar 335* unit. Install five standoffs **9**. Install four screws **30** and nuts **20**.
	n. Motor/blower assembly **15** (Figure 4-2) harness	n. Connect to J1 on PCB **7**.
	o. Audible alarm **24** harness	o. Connect to J8 on PCB **7**.
	p. Cooling fan **16** harness	p. Connect to J9 on PCB **7**.
	q. Wire harness **31** (Figure 4-2)	q. Connect to J4 on PCB **7**.
	r. Capacitor **6** harness	r. Connect to J5 on PCB **7**.
	s. CPU PCB **11**	s. Follow installation procedure 6 (steps h through n).
	t. Rotary actuator assembly **25**	t. Follow installation procedure 2 (Figure 4-2) (steps p through ac).
	u. Top housing assembly **4**	u. Follow installation procedure 1 (Figure 4-1) (steps o through ae).

Parts List (Figure 4-1)

Item	Part Number	Description
1	Included in 4	7 ¼" Spacer
2	Included in 4	Control Panel KS335
3	Included in 4	Outlet Connector KS335
4	S-290601-US	Spare, Cover Assembly (U.S.) (Used on Product P/N Y-126812-00E)
	S-290601-CA	Spare, Cover Assembly (FR CDN) (Used on Product P/N Y-126812-FCB)
	S-290601-00	Spare, Cover Assembly (U.S.) (Used on Product P/N S-126812-00D)
	S-290601-FC	Spare, Cover Assembly (FR CDN) (Used on Product P/N S-126812-FCA)
	S-290601-IN	Spare, Cover Assembly (International)
	S-290601-FR	Spare, Cover Assembly (French)
	S-290601-GE	Spare, Cover Assembly (German)
	S-290601-IT	Spare, Cover Assembly (Italian)
	S-290601-SP	Spare, Cover Assembly (Spanish)
5	Included in 23	Lock Washer #8
6	Included in 23	Acorn Nut 8-32
7	S-645023-00	Inlet Filter
8	S-290600-00	Spare Inlet Baffle
9	S-232161-03	Power Cord Assembly (U.S.)
	S-232161-02	Cord, AC PWR (Cont. EUR)
	S-232161-01	Power Cord Assembly(Italian)
	S-232161-00	Power Cord Assembly(U.K.)
10	Included in 24	Bumper
11	Included in 23	6 - 32 x .5" Screw
12	S-290619-00	Spare, 2.0 Amp Fuses
	S-290619-01	Spare, 3.15 Amp Fuses
13	S-290618-00	Spare, Fuse Drawer
14	Included in 24	Rubber Foot
15	Included in 23	Screw 8 - 32 x .437"
16	Included in 18	Handle Bracket
17	Included in 23	Screw 8 - 32 x .25"
18	S-290624-00	Spare Handle Kit
19	S-231850-04A*	Keypad Harness Cable Assembly, Control Panel
20	Included in 23	Jack Screw
21	Included in 23	Nut
22	S-231850-03A*	Cable Assembly (included in 35, Figure 4-2)
23	S-290625-00	Spare, Cover Hardware Kit (not shown)
24	S-290623-00	Spare Feet Kit (not shown)

* These items are available to Nellcor Puritan Bennett service centers only.

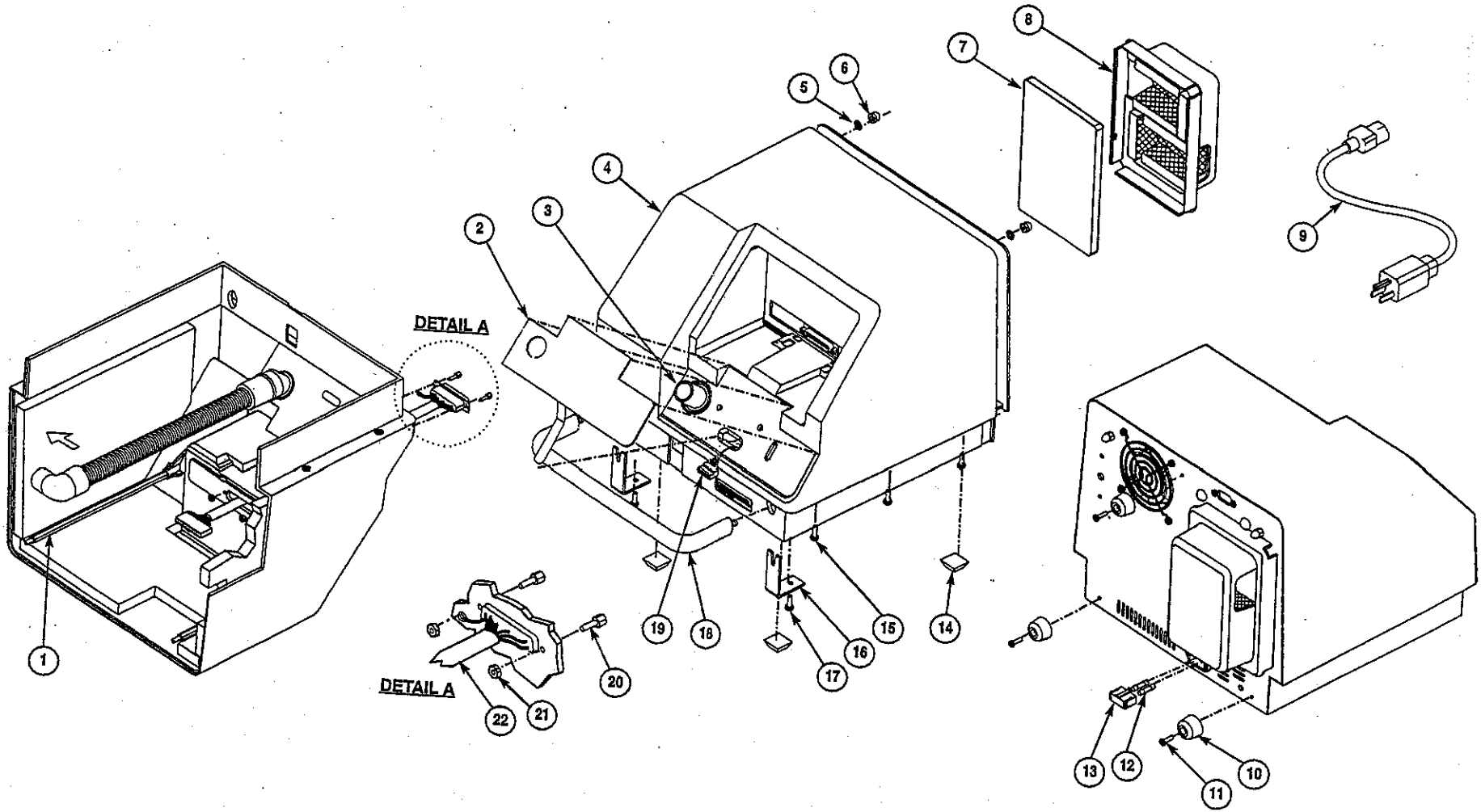

Figure 4-1: Base Unit

Parts List (Figure 4-2)

Item	Part Number	Description
1	Included in 33	Screw 6 - 32 x .25"
2	Included in 35	Wire Harness
3	S-867558-00A*	RFI Filter
4	S-611641-00A*	Coupling/Tubing 0.75" ID x 1.25" SIL
5	S-616394-00A*	Tee Conector
6	S-611637-00A*	Tubing Smooth Bore 15-Inch Cuffed
7	Included in 33	Screw
8	S-425512-00A*	Sound Bracket
8 a	S-614541-13A	Sound Foam 3" x 3"
8 b	S-614541-00A	Sound Foam 0.6" x 1.27"
8 c	S-614541-01A	Sound Foam 1.5" x 1.27"
9	Included in 33	Screw 6-32 x .5"
10	S-611638-00A*	Tubing Smooth Bore 14-Inch Cuffed
11	S-290599-00A	Spare, Filter Housing Assembly
12	S-611634-00A*	Tube
13	Included in 4	Tie Wrap
14	Included in 34	Nut 10-32 UNC-2B
15	S-290576-00A	Spare, Motor/Blower Assembly
16	Included in 4	Nut 8-32
17	Included in 34	Bracket
18	Included in 34	Lock Washer #10
19	Included in 34	Screw 10-32 x .312"
20	Included in 34	Vibration Mount
21	Included in 34	Washer #8
22	Included in 34	Acorn Nut 8-32
23	Included in 35	Wire Harness
24	S-425511-00A*	Chassis
25	S-290587-00	Spare Rotary Actuator
26	Included in 33	Manifold Bracket
27	S-616479-00	Manifold Valve KS335
28	Included in 33	Screw 6-32 x .5"
29	S-611636-00A*	Tube 10"
30	S-611635-00A*	Tube 7"
31	Included in 35	Wire Harness
32	Included in 33	Tie wrap
33	S-290621-00	Spare Actuator/Housing Hardware Kit (not shown)
34	S-290620-00	Spare Motor Blower Hardware Kit (not shown)
35	S-290622-00	Spare Cable Kit (not shown)

* These items are available to Nellcor Puritan Bennett service centers only.

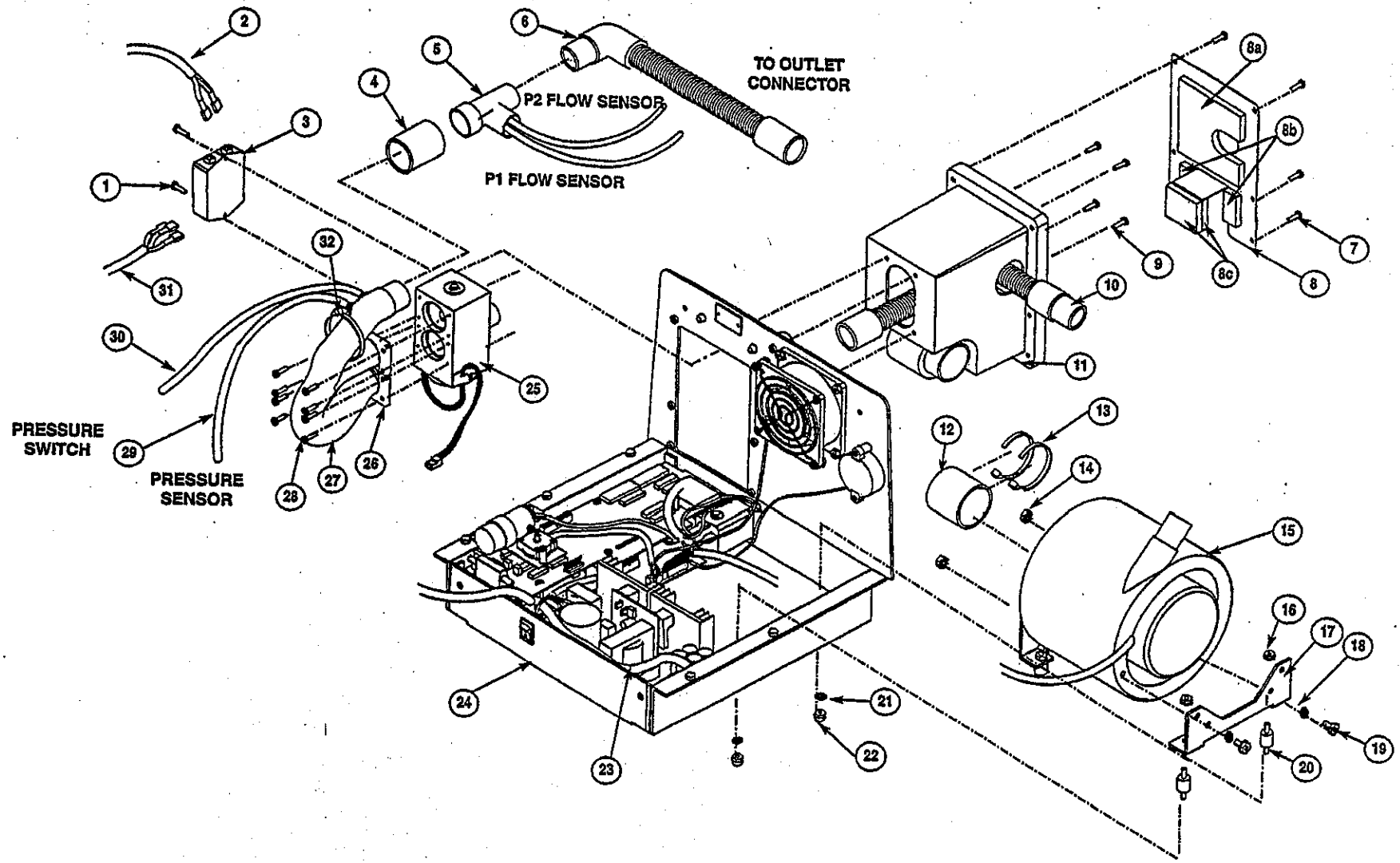

Figure 4-2: Pneumatic Components

Parts List (Figure 4-3)

Item	Part Number	Description
1	S-415212-00A*	Pressure Switch Bracket
2	S-290593-00	Pressure Switch/Harness
3	Included in 31	Screw 4-24 x .75"
4	S-616476-00A*	Nylon Clamp
5	Included in 31	Nut 6-32 UNC-2B
6	S-290628-00	Spare, Capacitor Harness
7	S-290585-00	Spare, Power Controller PCB
8	S-415216-00A*	Plate, Heatsink
9	Included in 31	Standoff 1.125"
10	Included in 31	Screw 4-40 x .312"
11	Y-290583-00	Spare, CPU PCB
12	Included in 31	Screw 4-40 x .312"
13	Included in 32	Cover
14 a&b	Included in 32	Screw 6-32 x .5"
15 a&b	S-867404-01A*	Fan Guard 3" x 3"
16	S-290588-00A	Spare, Fan Assembly
17 a&b	Included in 32	Nut 6-32 UNC-2B
18	Included in 32	Screw 4-24 x .25"
19	S-838973-00A*	Hole Plug, Bumper - 0.5000 Round (Included in 24, Figure 4-1)
20	Included in 31	Nut 4-40 UNC-2B
21	Included in 32	Nut 6-32 UNC KEPS
22	S-290617-00	Spare, AC Power Module
23	Included in 32	Screw 4-24 x .375"
24	S-290589-00	Spare, Alarm Assembly
25	Included in 32	Screw 4-40 x .312"
26	S-290584-00	Spare, Power Supply PCB
27	Included in 31	Screw 4-40 x .5"
28	S-290629-00	Spare Power Switch KS335
29	Reference	Stud
30	Included in 31	Screw 4-40 x .5"
31	S-290626-00	Spare, PCB Hardware Kit (not shown)
32	S-290627-00	Spare, Back Plate Hardware Kit (not shown)

* These items are available to Nellcor Puritan Bennet service centers only.

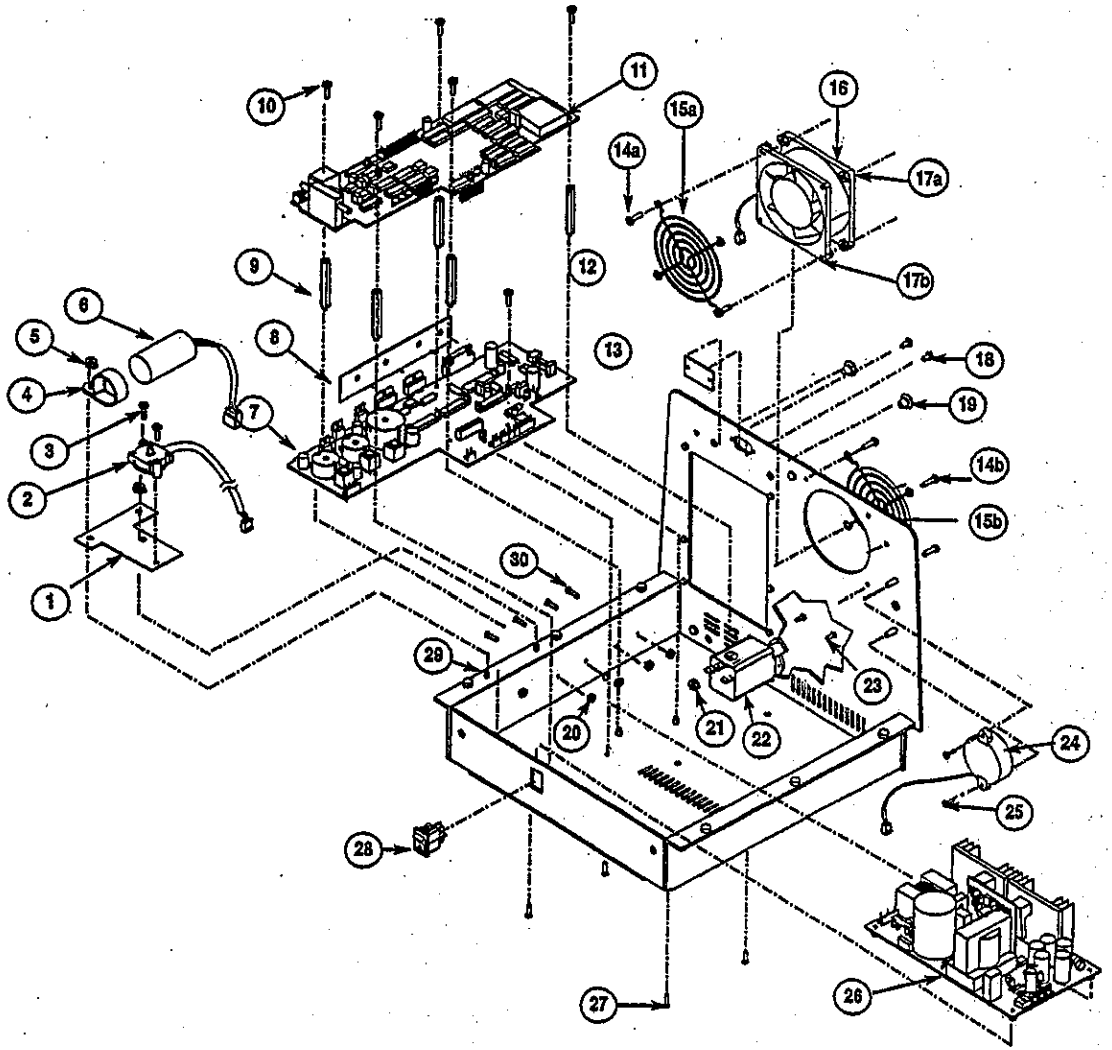

Figure 4-3: Electronic/Electric Components

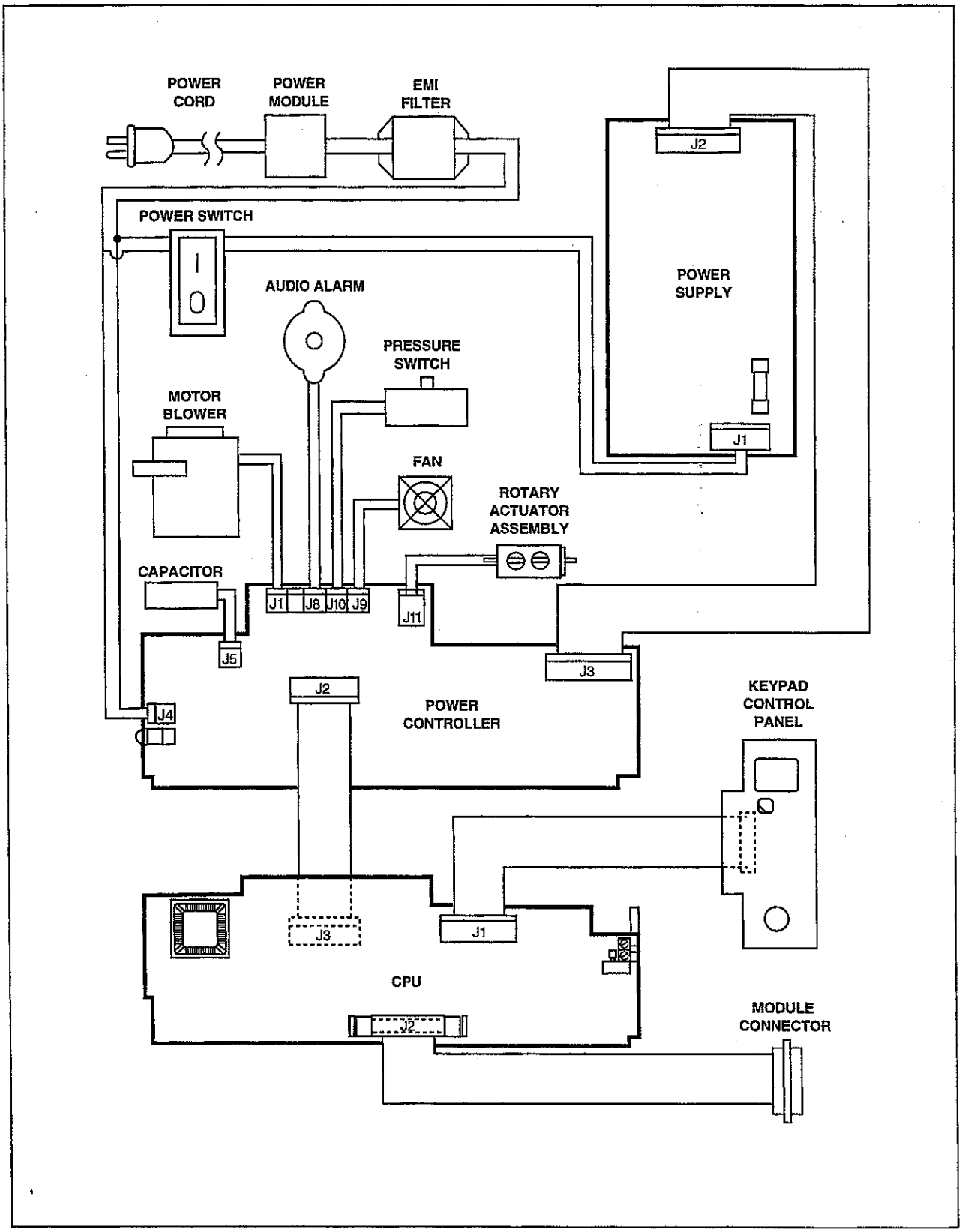

Figure 4-4: Wiring Schematic

4.2 *KnightStar 335* Calibration Procedure

Field calibration of the *KnightStar 335* should not normally be necessary. All replacement circuit boards are factory calibrated. However, service replacement of various key components may affect PCB calibration. If calibration is required, perform the procedures only as outlined in this section. DO NOT ADJUST ANY OTHER POTENTIOMETERS OTHER THAN THOSE SPECIFIED.

WARNING:
After calibration, verify correct operation by completing Section 3.3 Performance Verification.

Preparation for Calibration

1. Perform top housing assembly REMOVAL procedure, Table 4-1.
2. Connect the wire harness to J2 of the CPU PCB.
3. Connect the control module to the base unit.

WARNING:
The *KnightStar 335* is electrically powered. To prevent serious injury or death, use care while performing the calibration procedure.

4. Connect the AC power cord to the rear of the *KnightStar 335* and an AC wall outlet.

Pressure Transducer Calibration

1. Connect a circuit with the calibration shell to the base unit.
2. Connect the pressure port of the calibration shell to the RT-200.
3. Use the control module to set the IPAP and EPAP pressures at 3 cmH_2O.
4. Verify reading of RT-200 is 3 cmH_2O +1. If necessary adjust potentiometer R30 on the CPU PCB to attain desired reading on RT-200.
5. Use the control module to set IPAP and EPAP pressure to 20 cmH_2O.
6. Verify reading of RT-200 is 20 cmH_2O +1. If necessary adjust potentiometer R94 on the CPU PCB to attain desired reading on RT-200.
7. Repeat steps 3 through 6 until both adjustments fall within the specification.

NOTE:
Adjusting either potentiometer will effect the adjustment of the other. Each will have to be tested after an adjustment has been made.

4.3 Control Module Type 1 Service Procedures

Service and replacement procedures for the control module are provided in Table 4-2 as follows:

Table 4-2 Service Procedures for Control Module Type 1

(Refer to appropriate figure[s] for numbers shown in bold print.)

Component	Procedure number
Housing	1
Connector PCB	2
Master PCB	3
Display PCB	4

Component	Step/Item	Action
4.3.1. Housing assembly **9** (Figure 4-5)		
Removal	a. Control module	a. Remove from the *KnightStar 335* unit. Turn the control module so that the back is facing towards you.
	b. Two screws **1** and two screws **3**	b. Remove the screws from the back plate 2 of the control module.
	c. Back plate assembly **2**	c. Carefully separate the back plate about two inches from the housing assembly. Disconnect wire harness 5 connected to connector PCB **14** at J1.
Installation	d. Housing assembly **9**	d. Place housing assembly face down.
	e. Wire harness **5**	e. Connect to connector PCB **14** at J1.
	f. Back plate assembly **2**	f. Insert two screws **1** through bottom holes of back plate. Place spacers **4** over screws **1.**
	g. Housing assembly **9**	g. Place back plate against the housing assembly and align the screws **1** with bosses in the housing assembly. Tighten screws 1.
	h. Screws **3**	h. Place screws in upper holes in the back plate and tighten.
4.3.2. Connector PCB **14** (Figure 4-5)		
Removal	a. Housing assembly **9**	a. Perform removal procedure 1 (steps a through c) Table 4-2.
	b. Analog output jacks	b. Remove three nuts **16** and washers **15.**
	c. Input connector	c. Remove two screws **17.**
	d. Connector PCB **14**	d. Remove from back plate **2.**
Installation	e. Connector PCB **14**	e. Place connector PCB onto back plate **2.** Fasten connector PCB to back plate with two screws **17.**
	f. Analog output jacks	f. Place one washer **15** over each analog output jack. Install one nut **6** on each of the three analog output jacks and tighten .
	g. Back plate assembly	g. Perform installation procedure 1 (steps d through h) Table 4-2.

Component	Step/Item	Action
4.3.3. Master PCB 7 (Figure 4-5)		
Removal	a. Housing assembly **9**	a. Perform removal procedure 1 (steps a through c) Table 4-2.
	b. Insulator **6**	b. Remove from master PCB **7**
	c. Keypad harness **10**	c. Disconnect the keypad harness from the master PCB at J1.
	d. Master PCB **7**	d. Remove two screws **13** from master PCB. Carefully separate master PCB from display PCB **8**.
Installation	e. Master PCB **7**	e. Carefully connect master PCB to display PCB **8**. Install and tighten two screws **13**.
	f. Keypad harness **10**	f. Connect to the master PCB at J1.
	g. Insulator **5**	g. Install insulator on master PCB **7**.
	h. Back plate assembly	h. Perform installation procedure 1 (steps d through h) Table 4-2.
4.3.4. Display PCB **8** (Figure 4-5)		
Removal	a. Housing assembly **9**	a. Perform removal procedure 1 (steps a through c) Table 4-2.
	b. Master PCB **7**	b. Perform removal procedure 2 (steps a through d) Table 4-2.
	c. Four supports **11**	c. Use needle nose pliers to squeeze the support tab in and pry up the corner of the display PCB beyond the level of the tab. Repeat this procedure on each corner of the display PCB **8**.
	d. Display PCB **8**	d. Carefully lift the display PCB clear of the supports **11**.
Installation Housing	e. Display PCB **8**	e. Place the display PCB in the assembly **9** with the notched corners of the display PCB at the top of the housing assembly. Push the display PCB down beyond the tabs on the supports **11**.
	f. Master PCB **7**	f. Perform installation procedure 3 (steps e through g) Table 4-2.
	g. Back plate assembly	g. Perform installation procedure 1 (steps d through h) Table 4-2.
	h. Two screws **15**	h. Place two screws in the top holes of the back plate and tighten.